

from volcanoes, although, in the older mountains to the east of these, signs of volcanic activity are not absent. Still, since Triassic times, that is since the Sierra Nevadas were begun, there have been no volcanoes east of the Mississippi. During the earliest age of the earth's history, the Archean, New England and the seaboard States south of this region were disturbed by volcanic action. Again, in Paleozoic times, perhaps during the formation of the Appalachians, the same region was visited by volcanic disturbances, and during these periods the granites were intruded into the rocks and lavas sent out to the surface. Rocks of both these characters may still be seen in the vicinity of Boston.

A third and final great period of volcanic activity was developed in the Triassic period accompanying or immediately preceding a regrowth of the Appalachians and a faulting and folding of the rocks in a part of this region. These lavas were all black trap rock of remarkably uniform character from the Carolinas to Nova Scotia. On Cape Ann, in Massachusetts, there are hundreds of dikes of this lava cutting the granite, and the same is true of all the coast area in the region occupied by the volcanoes. These were either feeders of volcanoes or offshoots from feeders. The greater flows and intrusions of this rock may be seen in the Palisades of the Hudson; the trap hills of New Jersey, near Paterson, Orange, and other places; East and West rock of New Haven; the Hanging Hills, near Meriden, Conn.; Mount Holyoke, in Massachusetts; and elsewhere.

Thus a country which is now but little disturbed by volcanic eruptions has been, like most equally large regions in the world, the witness of numerous periods of activity during the past geological ages. The architecture of the continent has, as an essential part of its structure, numerous and various igneous rocks, and we are now profiting by their presence and the influence which they have exerted upon the rocks and minerals of the country. Not only are they an important element in the scenery of the country, but also they have exerted an essential influence upon the mineral wealth. All volcanic rocks carry metals in a very disseminated condition. By processes which cannot be described here these have been gathered together into mineral veins, and the greater part of our mineral wealth is either primarily or indirectly derived from this source. Therefore, where volcanic rocks are abundant there also we find the greatest abundance of ores. While this is the essential feature for the origin of metaliferous deposits, there are also other causes which aid in their accumulation, and the formation of mineral veins is not as simple as one might suppose from this general statement. But to volcanic activity, of one period or another, we owe not only the granite which we use in building, but many of the metals which are used in the arts; and it may be safely stated that had this country been free from such activity, our metallic wealth would have been very limited. In the central States, where volcanoes have been practically absent, the production of metals is unimportant; in the Eastern States, chiefly because of the absence of recent volcanoes, the product of metals (barring iron, which is present everywhere in the rocks), while more important than in the Central States, is still far less important than that of the Cordilleras, where the strata are crossed by and bedded with a maze of volcanic rocks of all ages and kinds. In the non-volcanic regions the metals which do exist would, no doubt, be found to have originated in igneous rocks, if their history could be traced. A part of our store of metallic wealth came, no doubt, from the original crust, but this original supply has been decidedly added to by the addition of fresh stores from the regions beneath the crust.

ANCIENT GLACIAL MORaine AND DRIFT AT THE MOUTH OF THE COLUMBIA RIVER.

By W. HAMPTON SMITH.

A GEOLOGICAL formation of more than ordinary interest exists on the north bank of the Columbia River, near its mouth, and directly opposite the city of Astoria, at what is known as Chinook Point, in the form of an ancient glacial moraine. By ancient I mean many thousands of centuries before our last glacial period. The Columbia River at its mouth forms an extensive estuary reaching about 40 miles into the interior, and varying from 4 to 10 miles in width.

At the point in question it is 4 miles wide and about 6 miles from the open sea. At the western extremity of the section under discussion the hills rise abruptly about 1,200 ft. and extend eastward along the river at about the same average height for about 5 miles, with perpendicular cliffs at many places of a hundred feet or more in height. The extreme western end of this range of hills is called Scarborough Hill, after Captain Scarborough, who settled here some 50 years ago. This hill is of volcanic origin, the rock being compact and more resembling diorite than anything else I know of. To the eastward of this eminence the hills are composed of gray sandstone and shale, some 800 or 900 feet in thickness. The sandstone is compact and massive, much of it very hard, and so far as I have been able to determine destitute of fossils. The strata have a slight southeasterly dip, and I think belong to the Cretaceous era. On top of this, and further to the east, reposes a fine hard blue shale. On top of this again, and still further to the east, rests a more recent, friable shale approaching moraine.

The sandstone disappears under these shales, which seem to be hundreds of feet in thickness, and on the south or Oregon side of the river, the friable shales only appear.

Now come the interesting part of my story. Beneath this stupendous pile of sandstone and shale lies for more than 2 miles in length, and from 30 to 50 ft. in thickness, a mass of glacial debris so ancient that it has become metamorphosed by heat or other agencies, so that it is a solid, compact rock, having all the structural form of moraine and loess so common to our modern glacial phenomena. It is not gravel conglomerate, so often seen in different portions of the globe, but earthy matter filled with fragmentary rocks and boulders, some of which are 8 ft. in length by $5\frac{1}{2}$ in width, and 4 ft. thick.

In some portions of this wonderful formation these boulders are very numerous, ranging from 1 foot up to 6 and 8 ft., and of quite a variety of rock. Some are sandstones, some are finely laminated argillaceous shales, one of the latter being 6 ft. in diameter, but for the most part they are of some form of trap rock. The larger boulders are nearly all rounded, more or less. One or two I noticed were square and angular. I found no quartzite in any instance, such as is so frequently mixed with our Western glacial debris. I found a few small cement boulders. All intermixed with these larger stones are smaller ones, down to earthy matter, but in no instance did I find sand forming the filling between the coarser debris,

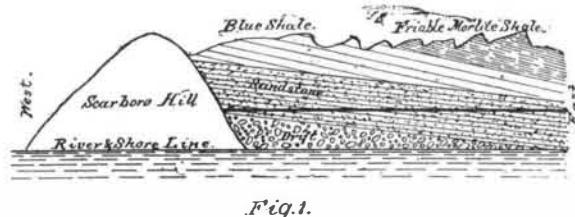


Fig. 1.

such as would naturally be the case were this the work of the waves, disintegrating a rocky cliff on a subsiding coast.

The portion of this ancient glacial deposit containing the larger boulders does not extend over about 300 yards up and down the river along the bluff.

A mile farther to the west in the cliff they are very numerous, but not so dense.

On either side of this boulder formation for a considerable distance is a thick deposit of what appears to be a metamorphosed bed of loess or glacial earth. It presents in some places an exposure of 25 or 30 ft. perpendicular height, and is to all intents and purposes stone granulated and somewhat easily decomposed by the weather and waves.

It contains small fragments of stone of various kinds sparingly. I am forcibly reminded by the character and relative position of these formations of our modern moraines and finer glacial debris that are nearly everywhere present in this great Northwest.

I imagine that, if a high degree of heat combined with pressure were brought to bear on our modern drift of like quality and position, it would present the

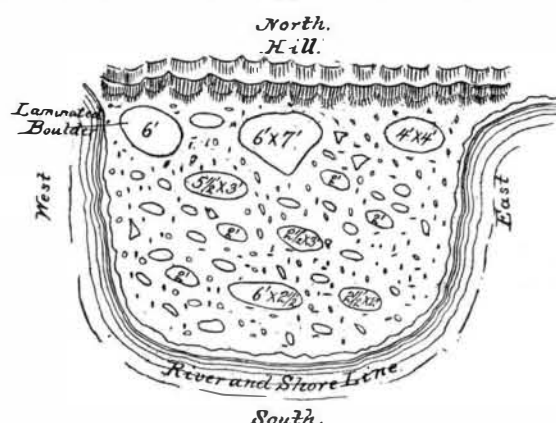


Fig. 2.

same appearance, varied only by the character of the material. Through the metamorphosed loess drift there is a basaltic dike protruding. This dike on one side of a point extending into the river is $4\frac{1}{2}$ ft. wide and on the other side of the same point, 150 ft. distant, it is 4 ft. wide, with walls on either side of the dike as clear cut and true as if it had been done by a carpenter and joiner. It is nearly vertical and the walls on either side do not show any signs of fusion, even where there is an immediate contact. Twelve or fifteen inches from either side of the dike toward the center is a very hard compact basalt, with the columnar structure horizontal from either side, the columns being small. About 18 in. of the center is divided into vertical bends of about 3 in., separated partially by porous seams. These seams and the center of the dike contain crystals of feldspar, giving it the appearance of diorite. This would indicate that the presence of crystals of feldspar was due more to a thermal condition of the outflow than to its place of origin.

There are no signs of any flow of lava along the shores coming from this vent hole. The whole shore line has been eroded off, some places leaving perpen-

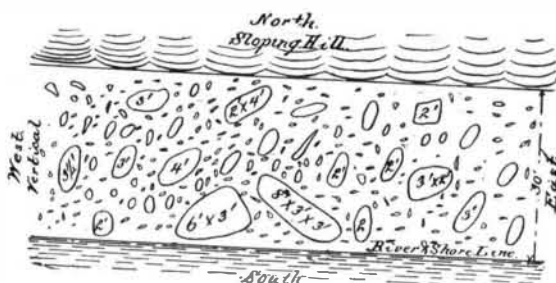


Fig. 3.

dicular cliffs 100 ft. high, by the great modern Columbia River glacier, that poured into the sea at this place.

I consider this a most remarkable formation. The sandstone overlying this drift lies squarely upon it, and is apparently 800 ft. or more in thickness.

There is no trap rock resembling this that I know of, within many miles of this location. The formation at Scarborough Hill is widely different from this wreckage. Some twenty miles up the Columbia River are vast quantities of columnar basalt, but it is of much more recent date than the formation in question, and of decidedly a different type. I stand and look upon these huge boulders buried beneath a mountain of sedimentary rock—old and gray with the centuries that

have passed into eternity—with a sense of bewilderment.

It overturns some of my most cherished theories in reference to the scope of glacial phenomena. I have always contended that there was but one glacial catastrophe, and, if it be true that this formation is true glacial, it shows that the earth in its comparative youth has been subjected to desolation and death, commonly ascribed to old age, and that it has probably been populated and depopulated many times during its long unwritten history.

Everything associated with this strange deposit seems to point to a glacial origin, and yet, in spite of this, I am forced into a state of skepticism, because it

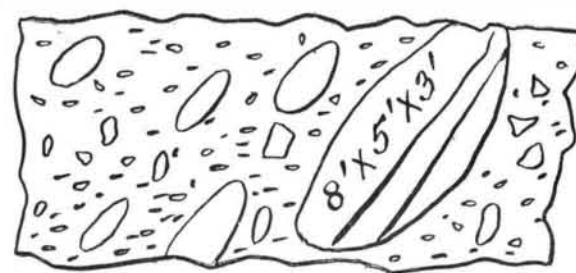


Fig. 4.

seems to stand across the path of other great natural laws, by which this earth is controlled. May it not be the wreckage from a cliff forming the center of this range of hills on a subsiding coast? But, if so, how does it come that the band of fine debris is not sand, instead of earthy matter, as we see in all like wreckage on subsiding coasts at this day?

I have given as faithful an account of this formation as a casual study of it will admit. I send hasty pencil sketches of the location and different portions of the deposit, which will convey a limited idea of the nature of it.

Fig. 1 is a diagram of the various phases of the locality under discussion and is a vertical section. The spectator is facing north and the view covers about 3 miles. For a greater part of the distance to a point indicated by the heavy black line is a perpendicular bluff near a hundred feet high. The boulders protrude from the face of the cliff. The exposure of the drift for much of the distance is 40 to 50 ft. in height.

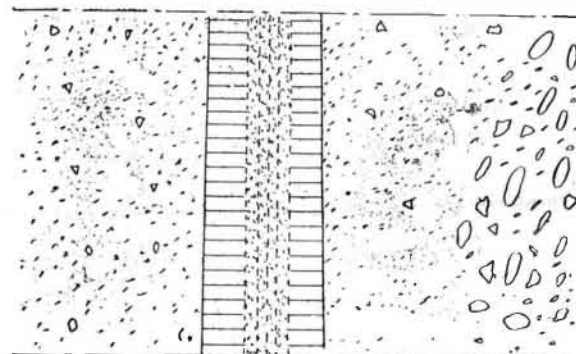


Fig. 5.

The face of the sandstone above is about the same number of feet, when the hill recedes, with great ribs of rock exposed till the summit is reached, some 900 ft. high. Further up the river, the sand rock disappears beneath the water, when nothing but shale is visible.

Fig. 2 is a horizontal section that has been eroded on top by the storm waves, leaving an exposure of a surface 100×50 ft. The beholder is looking down on the drift. The circles are the boulders with their dimensions in feet. The balance is a conglomeration of all sizes and varieties of debris.

Fig. 3 is a vertical section about 50 ft. to the east of Fig. 2, and is 75 or 100 ft. in length and about 30 ft. in perpendicular height. It is in a cove made by the waves, which in a storm beat with great fury on this shore, carving it into little bays, inlets and grottoes of the most pleasing and picturesque form.

As before, the large circles are the boulders, with their dimensions marked in feet. It is really a continuation of Fig. 2 to the east, only vertical.

Fig. 4 represents a large fragment that has fallen from the cliff, where it has been undermined by the waves. It is about $18 \times 10 \times 5$ ft., and is composed of boulders and other wreckage. The large boulder has several large cracks in it, as indeed many others seem to have, caused apparently by heat. This fragment has fallen from Fig. 3.

Fig. 5 is a basaltic dike, some $4\frac{1}{2}$ ft. wide, protruding through what I call metamorphosed loess or glacial soil. It is banded in the center with vertical porous lines some 3 in. apart, containing crystals of feldspar. The central third contains feldspar crystals. The outer two thirds is plain basalt. The metamorphosed loess appears on either side graduating into regular morainic boulders on the right.

Astoria, Oregon, July 10, 1893.

FOGS, CLOUDS AND LIGHTNING.

MR. SHELFORD BIDWELL, M.A., F.R.S., in a recent lecture at the Royal Institution on the above subject, began by speaking of the popular idea that what is seen coming from the chimney of the locomotive or the spout of the tea-kettle is steam, whereas it is cloud, and steam is invisible. Nevertheless, he thought that scientific men had acted in a high-handed manner by taking an old word and attaching to it a new meaning of their own; as Humpty Dumpty said to Alice, "It is a question which is to be master, that's all."

Then, by experiments inside glass globes containing common air, he showed how the expansion of air by means of an air-pump will sufficiently chill it to